The Electrochemical Society . . .

108th Meeting

PITTSBURGH

October 9th-13th, 1955

LOCAL COMMITTEE

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J. C. Warner

General Chairman
J. Paul Fugassi

Arrangements
Eldridge K. Camp, *Chairman*
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Finance
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Membership
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Plant Trips
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Publicity
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THE ELECTROCHEMICAL SOCIETY

One Hundred and Eighth Meeting

Sunday through Thursday

October 9, 10, 11, 12, and 13, 1955

CONDENSED TECHNICAL PROGRAM

Battery (Abs. 1–4)

(All sessions in Allegheny Room)

Monday, October 10—9:30 A.M.–11:30 A.M.

Monday, October 10—2:30 P.M.–5:00 P.M., Round-Table Discussion

Tuesday, October 11—9:00 A.M.–12:00 M., Round-Table Discussion

Tuesday, October 11—2:30 P.M.–4:00 P.M., Round-Table Discussion

Corrosion (Abs. 5–45)

(Monday, Tuesday, Wednesday in Urban Room; Thursday in Sky Room)

Monday, October 10—10:00 A.M.–12:00 M.

Monday, October 10—2:00 P.M.–5:00 P.M.

Tuesday, October 11—9:00 A.M.–12:00 M.

Tuesday, October 11—2:00 P.M.–4:00 P.M.

Wednesday, October 12—9:00 A.M.–11:30 A.M.

Wednesday, October 12—2:00 P.M.–5:00 P.M.

Thursday, October 13—9:30 A.M.–12:00 M.

Thursday, October 13—2:00 P.M.–3:30 P.M.

Electrodeposition (Abs. 46–58)

(All sessions in Allegheny Room)

Wednesday, October 12—9:00 A.M.–11:30 A.M.

Wednesday, October 12—2:30 P.M.–4:30 P.M. Round-Table Discussion

Thursday, October 13—9:00 A.M.–12:30 P.M.

Electronics-Semiconductors (No abstracts)

(All sessions in Monongahela Room)

Thursday, October 13—9:00 A.M.–12 M.

Thursday, October 13—2:00 P.M.–5:00 P.M.

Electro-Organic (Abs. 59–80)

(All sessions in Monongahela Room)

Monday, October 10—10:00 A.M.–11:30 A.M.

Monday, October 10—2:15 P.M.–5:15 P.M.

Tuesday, October 11—9:00 A.M.–11:30 A.M.

Tuesday, October 11—2:00 P.M.–3:30 P.M.

Wednesday, October 12—9:00 A.M.–11:30 A.M.

Wednesday, October 12—2:00 P.M.–5:00 P.M.

Electrothermics and Metallurgy (Abs. 81–101)

(All sessions in the Sky Room)

Monday, October 10—2:30 P.M.–4:30 P.M.

Tuesday, October 11—9:30 A.M.–12:00 M.

Tuesday, October 11—2:00 P.M.–4:00 P.M.

Wednesday, October 12—9:30 A.M.–11:30 A.M.

Wednesday, October 12—2:00 P.M.–4:00 P.M.

GENERAL INFORMATION

Convention headquarters will be at the Hotel William Penn, Grant Street, Pittsburgh, Pa.

Rates per day for rooms (with bath) will be: single-bed room (one person) $8.00, 8.50, 9.00, 9.50, 10.00, 10.50; double-bed room (two persons) $11.50, 12.00, 12.50, 13.00, 14.00; twin-bed room (2 persons) $11.50, 12.00, 13.00, 14.00, 15.00, 16.50; suites, parlor and twin-bed room, $25.00, 30.00, 35.00; parlor, two twin-bed rooms, $46.50, 50.00.

Requests for rooom reservations should be mailed to office of the General Manager, Hotel William Penn, Pittsburgh 30, Pa., with mention of The Electrochemical Society.

Technical sessions and registration will be on the 17th (Ballroom) floor, as will be the Secretary's Office (Parlor D) and Ladies' Headquarters (Parlor E).

Registration desk (17th floor) will be open during the following periods: Sunday, October 9, 5:00 P.M. to 8:00 P.M.; Monday, 8:00 A.M. to 5:00 P.M.; Tuesday and Wednesday, 8:30 A.M. to 5:00 P.M.; Thursday, 8:30 A.M. to 12:00 M. Registration fees are:

Members	$7.00
Nonmembers	$13.00
Ladies	$3.00
Students	$2.00

ROUND TABLES AND SPECIAL SYMPOSIA

The Battery Division has scheduled three round-table discussions: 1. Methods of Dry-Charging Storage Batteries, Monday, October 10, at 2:00 P.M. in the Allegheny Room; 2. Processes Which Limit the Shelf-Life and Charge Retention of Batteries (Reactions at Negative Electrodes), Tuesday, October 11, at 9:00 A.M. in the Allegheny Room; 3. Processes Which Limit the Shelf-Life and Charge Retention of Batteries (Reactions at Positive Electrodes), Tuesday, October 11, at 2:30 P.M. in the Allegheny Room.

The Electrodeposition Division has scheduled a special symposium on Hydrogen Embrittlement, Wednesday, October 12, at 9:00 A.M., and a round-table discussion on Hydrogen Embrittlement, Wednesday, October 12, at 2:30 P.M. in the Allegheny Room.

The Electro-Organic Division has scheduled a round table discussion on Mechanism of Reduction, Wednesday, October 12, at 2:00 P.M. in the Monongahela Room.

The Electrothermics and Metallurgy Division has scheduled a special symposium on Fluidized Solid Techniques on Monday, October 10, at 2:30 P.M. in the Sky Room.

PALLADIUM MEDAL LECTURE

Dr. Ulick R. Evans, of Cambridge, England, will deliver the Palladium Medal Lecture at 4:00 P.M., Tuesday, October 11, in the Urban Room.

LUNCHEONS AND DINNERS

Monday Luncheon

The Society Luncheon will be held Monday, October 10, at 12:30 P.M. in the Monongahela Room. Speaker will be the Honorable John P. Robin, Secretary of Commerce, Commonwealth of Pennsylvania.

Monday Get-Acquainted Hour

On Monday, October 10, an informal get-acquainted hour will be held in the Fort Duquesne Room from 4:30 P.M.–8:00 P.M. Come and renew acquaintances. Information will be available on what to see and do in Pittsburgh. Refreshments will also be available.

Tuesday Palladium Medal Banquet

A reception and dinner in honor of the Palladium Medalist, Dr. U. R. Evans, will be held on Tuesday, October 11, in the Urban Room. Cocktails will be served at 6:30 P.M., dinner at 7:30 P.M.

Wednesday Theater Party

For those who enjoy the legitimate theater, Wednesday evening has been set aside for a theater party at the Pittsburgh Playhouse.

PLANT TRIPS

All trips are to leave the Hotel William Penn at 2:00 P.M. and leave plants at 5:00 P.M. for return to the hotel.

Monday, October 10

1. Irvin Works—U. S. Steel Corporation (Limit 45 persons. Persons who are not American citizens must make special arrangements at registration desk.)
2. The Pittsburgh Brewing Company—Iron City Brewery, 3340 Liberty Avenue (Limit 30 men)

Tuesday, October 11

3. The Pittsburgh Coke & Chemical Company, Neville Island (Limit 45 persons)

Wednesday, October 12

4. Elrama Power Station—Duquesne Light Company (Limit 45 persons. Persons who are not American citizens must make special arrangements at registration desk. A list of those attending, with company affiliations, must be furnished in advance.)
5. The Duquesne Brewing Company, S. 22nd St. (Limit 30 men)

LADIES' PROGRAM

Ladies' Headquarters will be in Parlor E on the Ballroom (17th) floor of the Hotel William Penn throughout the meeting. All ladies are requested to visit this headquarters and register for the program which has been arranged for their entertainment and information. The ladies' program has been arranged to cover interesting features of Pittsburgh and to provide for participation in entertainment features of the general convention, as well as to provide some free time for shopping and individual amusement.

Monday Morning—A get-acquainted meeting, with coffee and doughnuts, will be held at 9:30 A.M. in Parlor E. At this meeting discussion of arrangements for the features of the ladies' program will be held, as well as an opportunity for the ladies to get acquainted and express their wishes and desires in connection with the program. At 10:30 A.M. there will be a conducted tour of the new Alcoa Building.

Monday Noon—The ladies are invited to attend the Society Luncheon in the Monongahela Room at 12:30 P.M. (Price $3.50).

Monday Afternoon—Immediately following the luncheon, at 2:00 P.M. the ladies will board a bus to tour the Oakland Civic Center and the Nationality Rooms in the Cathedral of Learning at the University of Pittsburgh. They will return to the hotel about 4:30 P.M.

Monday Evening—The ladies are invited to attend the Get-Acquainted Hour in the Fort Duquesne Room from 4:30 P.M. to 8:00 P.M.

Tuesday Morning—Coffee will be served in the Ladies' Headquarters at 9:30 A.M. The rest of the morning is left open for shopping and individual tours of interest.

Tuesday Afternoon—At 12:30 P.M. buses will leave for a tour of the H. J. Heinz Co. Plant and a sight-seeing tour of the North Side, Block House, and Mt. Washington. Return about 4:30 P.M.

Tuesday Evening—Cocktails and dinner in honor of the Palladium Medalist, Dr. U. R. Evans, in the Urban Room at 6:30 P.M. ($10.50).

Wednesday Morning—Promptly at

9:30 A.M. a bus will leave for an all-day trip, via the Pennsylvania Turnpike, to Fort Ligonier. The return sight-seeing trip will be by Route 30. Return about 4:30 P.M. Tickets $3.00.

Wednesday Evening—Theater Party, stage play at the Pittsburgh Playhouse.

Thursday Morning—As usual, coffee will be served in the Ladies' Headquarters at 9:30 A.M. The remaining time is left open for shopping and individual entertainment. The Ladies' Committee will be glad to assist as guides or in just plain conversation. This is the time to satisfy individual desires, and the Ladies' Committee will be standing by to help in any way.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Battery Division will hold a luncheon and business meeting on Tuesday, October 11, at 12:30 P.M. in the Triangle Room (Club floor).

Corrosion Division will hold a luncheon and business meeting on Wednesday, October 12, at 12:30 P.M. in the Sky Room (17th floor).

Electrodeposition Division will hold a luncheon and business meeting on Wednesday, October 12, at 12:30 P.M. in the Fort Duquesne Room (17th floor).

Electro-Organic Division will hold a luncheon and business meeting on Wednesday, October 12, at 12:30 P.M. in Room 735 (7th floor).

Electrothermics and Metallurgy Division will hold a luncheon on Tuesday, October 11, at 12:30 P.M. in the Allegheny Room (17th floor).

BOARD AND COMMITTEE MEETINGS

(All meetings will be on the 17th floor.)

Sunday, October 9, 10:00 A.M.—Meeting of the Ways and Means Committee, Parlors B and C.

Sunday, October 9, 2:00 P.M.—Meeting of the Board of Directors, Parlors B and C.

Monday, October 10, 5:00 P.M.—Meeting of the Editorial Staff, Parlor B.

Monday, October 10, 5:00 P.M.—Meeting of Council of Local Sections, Parlor C.

Wednesday, October 12, 5:00 P.M.—Meeting of Membership Committee, Parlor B.

Wednesday, October 12, 5:00 P.M.—Meeting of Sustaining Membership Committee, Parlor C.

COST OF VARIOUS FUNCTIONS

(other than registration)

Society Luncheon.....$3.50
Division Luncheons.....$3.50
Palladium Medal Reception and Banquet
(single).....$6.50
(couple).....$10.50
(including one free cocktail, additional cocktails $0.25 each)
Ladies' Scenic Drive and Luncheon $3.00
Plant Trips.....$1.25
(*Gratuities and taxes included in above costs*)

JOURNALS

Copies of the June, July, August, and September issues of the JOURNAL

OF THE ELECTROCHEMICAL SOCIETY will be available at the registration desk. The price of single copies of the JOURNAL is $1.25 to members and $1.50 to nonmembers.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied by the symposium chairman with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division or to the Managing Editor of the JOURNAL after the session. The discussion will then be referred to the authors for reply. Written discussion should be submitted within two months following publication of any article in the JOURNAL.

A discussion section is published semiannually in the JOURNAL.

SLIDES AT TECHNICAL SESSIONS

The Board of Directors of the Society does not favor indiscriminate photographing of slides during technical sessions. It is requested that no such photographs be taken. Chairmen of technical sessions should administer this rule.

EMPLOYMENT POSTERS

Companies which desire to recruit employees at the Pittsburgh Meeting will have posters to this effect on a bulletin board near the registration desk.

MEETING ROOM SCHEDULES

Meetings	Monday		Tuesday		Wednesday		Thursday	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Battery	A	A	A	A				
Corrosion	U	U	U	U	U	U	S	S
Electrodeposition					A	A	A	
Electronics-Semiconductors							M	M
Electro-Organic	M	M	M	M	M	M		
Electrothermics and Metallurgy		S	S	S	S	S		

A—Meeting will be held in the Allegheny Room.
M—Meeting will be held in the Monongahela Room.
S—Meeting will be held in the Sky Room.
U—Meeting will be held in the Urban Room.

TECHNICAL PROGRAM

Monday, October 10, 1955

9:00 A.M.—Formal Opening of the 108th Convention with Introduction by General Chairman J. P. Fugassi and response by President H. H. Uhlig (Urban Room).

Battery

Monday, October 10, 1955

Research Contributions

with N. C. Cahoon presiding

(ALLEGHENY ROOM)

9:30 A.M.—"Resistivity Studies of Various Leclanché Cathode Materials" by Richard Glicksman and C. K. Morehouse, RCA Labs., Radio Corp. of America, Princeton, N. J. (Abstract No. 1)

10:00 A.M.—"A Polarization Technique for Evaluating Various Cathode Materials" by C. K. Morehouse and Richard Glicksman, RCA Labs., Radio Corp. of America, Princeton, N. J. (Abstract No. 2)

10:30 A.M.—"The Aluminum Dry Cell" by J. J. Stokes, Jr., Physical Chemistry Div., Aluminum Co. of America, New Kensington, Pa. (Abstract No. 3)

11:00 A. M.—"An Electron Diffraction Study of Lead Monoxides" by Jeanne Burbank, Electrochemistry Branch, Chemistry Div., Naval Research Lab., Washington, D. C. (Abstract No. 4)

12:30 P.M.—Society Luncheon in the Monongahela Room.

Battery

Round Table

Methods of Dry-Charging Storage Batteries

with Eugene Willihnganz presiding

(ALLEGHENY ROOM)

2:30 P.M.—Round-table discussion with panel of speakers, to be followed by general discussion.

Battery

Tuesday, October 11, 1955

Round Table

Processes Which Limit the Shelf-Life and Charge Retention of Batteries

(Reactions at Negative Electrodes)

with W. S. Herbert presiding

(ALLEGHENY ROOM)

9:00 A.M.—Round-table discussion with panel of speakers, to be followed by general discussion.

12:30 P.M.—Battery Division Luncheon and Business Meeting in the Triangle Room (Club floor).

Battery

Round Table (cont'd)

(Reactions at Positive Electrodes)

with U. B. Thomas presiding

(ALLEGHENY ROOM)

2:30 P.M.—Round-table discussion

with panel of speakers, to be followed by general discussion.

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4:00 P.M.—Palladium Medal Address by U. R. Evans, Cambridge, England, in the Urban Room.

Corrosion

Monday, October 10, 1955

Oxidation

with J. T. Waber presiding

(URBAN ROOM)

10:00 A.M.—"Oxidation of Oxygen-Free High Conductivity Copper, I. Oxidation of Copper to Cu_2O" by J. P. Baur, D. W. Bridges, and W. M. Fassell, Jr., Dept. of Metallurgy, University of Utah, Salt Lake City, Utah. (Abstract No. 5)

10:30 A.M.—"High Pressure Oxidation of Metals; Niobium in Oxygen" by D. W. Bridges and W. M. Fassell, Jr., Dept. of Metallurgy, University of Utah, Salt Lake City, Utah. (Abstract No. 6)

11:00 A.M.—"High Pressure Oxidation of Metals; Tungsten in Oxygen" by J. P. Baur, D. W. Bridges, and W. M. Fassell, Jr., Dept. of Metallurgy, University of Utah, Salt Lake City, Utah. (Abstract No. 7)

11:30 A.M.—"Oxidation of Tungsten" by W. W. Webb, J. T. Norton, and Carl Wagner, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 8)

12:30 P.M.—Society Luncheon in the Monongahela Room.

Corrosion

Oxidation (cont'd)

with J. T. Waber presiding

(URBAN ROOM)

2:00 P.M.—"Oxidation Studies in Metal-Carbon Systems" by W. W. Webb, J. T. Norton, and Carl Wagner, Dept. of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 9)

2:25 P.M.—"Role of Dislocation in the Oxidation of Metals" by N. Cabrera, Dept. of Physics, University of Virginia, Charlottesville, Va. (Abstract No. 10)

2:50 P.M.—"Oxidation of Iron-Molybdenum and Nickel-Molybdenum Alloys" by S. S. Brenner, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 11)

3:15 P.M.—"Catastrophic Oxidation of Some Molybdenum-Containing Alloys" by S. S. Brenner, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 12)

3:40 P.M.—"A Spectrophotometric Study of the Oxidation of Uranium" by J. T. Waber and G. E. Sturdy, Los Alamos Scientific Lab., University of California, Los Alamos, N. Mex. (Abstract No. 13)

4:05 P.M.—"Oxidation of Iron-Nickel Alloys" by R. T. Foley, General Engineering Lab., General Electric Co., Schenectady, N. Y., and R. E. Fryxell and J. U. Druck, Transformer Labs. Dept., General Electric Co., Pittsfield, Mass. (Abstract No. 14)

4:30 P.M.—"Reaction of Hydrogen with Uranium" by W. M. Albrecht

and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 15)

Corrosion

Tuesday, October 11, 1955

Kinetics of Corrosion Reactions

with J. E. Draley presiding

(URBAN ROOM)

9:00 A.M.—"Formation of Porous Scale" by C. E. Birchenall, James Forrestal Research Center, Princeton University, Princeton, N. J. (Abstract No. 16)

9:30 A.M.—"Preliminary Results on the Kinetics of the Reaction of Metals with Water Vapor" by Paul Blackburn and E. A. Gulbransen, Westinghouse Research Labs., East Pittsburgh, Pa. (Abstract No. 17)

10:00 A.M.—"Oxidation Studies on Fe-Cr-Al Heater Alloys" by Kenneth Andrew and E. A. Gulbransen, Westinghouse Research Labs., East Pittsburgh, Pa. (Abstract No. 18)

10:30 A.M.—"Acceleration of the Dissolution of Iron in Sulfuric Acid by Ferric Ions" by H. C. Gatos, Engineering Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (Abstract No. 19)

11:00 A.M.—"Dissolution of Metals in Aqueous Acid Solutions, II. Kinetics for the Reactions of Steel" by N. M. Komodromos, A. C. Makrides, and Norman Hackerman, Dept. of Chemistry, University of Texas, Austin, Texas. (Abstract No. 20)

11:30 A.M.—"Effect of Alloying Elements in Iron on Hydrogen Over-

voltage and Corrosion Rate in Acid Environments" by Milton Stern, Corrosion Lab., Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 21)

Corrosion

Kinetics of Corrosion Reactions (cont'd)

with J. E. Draley presiding

(URBAN ROOM)

2:00 P.M.—"Dissolution of Cadmium in Chromic Chloride-Hydrochloric Acid Solutions" by C. V. King and Edward Hillner, Dept. of Chemistry, New York University, New York, N. Y. (Abstract No. 22)

2:30 P.M.—"Role of Hydrogen in Corrosion Reactions" by J. E. Draley and W. E. Ruther, Argonne National Lab., Lemont, Ill. (Abstract No. 23)

3:00 P.M.—"A Study of the Cathodic Reduction of Oxide Films on Iron, I. Reduction of Alpha-Fe_2O_3 Films" by H. G. Oswin and M. Cohen, Div. of Applied Chemistry, National Research Council, Ottawa, Ont., Canada. (Abstract No. 24)

3:30 P.M.—"Kinetics of Exchange Between Solid Copper and Silver Ions in Aqueous Solutions" by M. Simnad, A. Spilners, and Ling Yang, Metals Research Lab., Carnegie Institute of Technology, Pittsburgh, Pa. (Abstract No. 25)

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4:00 P.M.—Palladium Medal Address by U. R. Evans, Cambridge, England, in Urban Room.

Wednesday, October 12, 1955

Role of Surface Films in Corrosion

with R. B. Hoxeng presiding

(URBAN ROOM)

9:00 A.M.—"A Study of the Effect of Chloride Ion on Films Formed on Iron in Sodium Nitrite Solutions" by G. W. Mellors, M. Cohen, and F. Beck, Div. of Applied Chemistry, National Research Council, Ottawa, Ont., Canada. (Abstract No. 26)

9:30 A.M.—"Mechanism of the Hydrogen Evolution Reaction on Silver and Tungsten Cathodes" by J. O'M. Bockris, Dept. of Chemistry, University of Pennsylvania, Philadelphia, Pa. (Abstract No. 27)

10:00 A.M.—"Oxygen Adsorption on Stainless Steel" by T. N. Rhodin, Jr., Engineering Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (Abstract No. 28)

10:30 A.M.—"Electrical Properties of the Oxide Film on Zirconium" by R. D. Misch, Argonne National Lab., Lemont, Ill. (Abstract No. 29)

11:00 A.M.—"Orthophosphates of Iron, Manganese, and Zinc" by Jeanne Burbank, Naval Research Lab., Washington, D. C. (Abstract No. 30)

12:30 P.M.—Corrosion Division Luncheon and Business Meeting in the Sky Room (17th floor).

with R. B. Hoxeng presiding

(URBAN ROOM)

2:00 P.M.—"Influence of Specimen Area on the Pitting Probability of Aluminum" by P. M. Aziz and H. P. Godard, Aluminium Labs., Ltd., Kingston, Ont., Canada. (Abstract No. 31)

2:30 P.M.—"Pitting Corrosion of 18 Cr-8 Ni Stainless Steel, I. Development of Accelerated Electrolytic Pit Initiation Methods" by M. A. Streicher, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (Abstract No. 32)

2:45 P.M.—"Pitting Corrosion of 18 Cr-8 Ni Stainless Steel, II. Investigation of Variables in the Metal and in the Electrolyte Which Control Pit Initiation" by M. A. Streicher, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (Abstract No. 33)

3:00 P.M.—"Determination of Corrosion Rates in Aqueous Systems at Elevated Temperature and Pressure by a Hydrogen Effusion Method" by M. C. Bloom and M. Krulfeld, Naval Research Laboratory, Washington, D. C. (Abstract No. 34)

3:30 P.M.—"Galvanic Corrosion Characteristics of Aluminum Alloys" by M. J. Pryor and D. S. Keir, Dept. of Metallurgical Research, Kaiser Aluminum & Chemical Corp., Spokane, Wash. (Abstract No. 35)

4:00 P.M.—"Crystallization of Anodic Tantalum Oxide Films in the Presence of a Strong Electric Field" by D. A. Vermilyea, Research Lab., General Electric Co., Schenectady, N. Y. (Abstract No. 36)

4:30 P.M.—"Various Factors Affecting the Formation of Anodic Oxide Coatings in Sulfuric Acid Electrolytes" by R. B. Mason, Aluminum Research Labs., Aluminum Co. of America, New Kensington, Pa. (Abstract No. 37)

Corrosion

Thursday, October 13, 1955

with J. V. Petrocelli presiding

(SKY ROOM)

9:30 A.M.—"Electrochemical Studies of Aluminum Corrosion in Water" by Manuel Shaw and S. B. Twiss, Chrysler Corp., Detroit, Mich. (Abstract No. 38)

10:00 A.M.—"Anodic Polarization of Zirconium at Low Potentials: Formation Rates, Formation Field, Electrolytic Parameters, and Film Thicknesses of Very Thin Oxide Films" by G. B. Adams, Jr., and Pierre Van Rysselberghe, Dept. of Chemistry, University of Oregon, Eugene, Oreg., and Mario Maraghini, Institute of Applied Chemistry, University of Rome, Rome, Italy. (Abstract No. 39)

10:30 A.M.—"Electrochemical Thermodynamics of J. Willard Gibbs and the Stockholm Conventions; The Gibbs-Stockholm Electrode Potential" by A. J. de Béthune, Chemistry Dept., Boston College, Chestnut Hill, Mass. (Abstract No. 40)

11:00 A.M.—"Electrochemical Potentials of Grains and Grain Boundaries in Copper Solid Solutions" by R. Bakish and W. D. Robertson, Ham-

mond Metallurgical Lab., Yale University, New Haven, Conn.
(Abstract No. 41)

11:30 A.M.—"Effect of Fluorides and Other Addition Agents on the Cathodic Potential of Titanium in Hydrofluoric Acid" by M. E. Straumanis, S. T. Shih, and A. W. Schlechten, Dept. of Metallurgy, School of Mines and Metallurgy, University of Missouri, Rolla, Mo.
(Abstract No. 42)

Corrosion

with T. P. May presiding

(SKY ROOM)

2:00 P.M.—"Natural and Thermally Formed Oxide Films on Aluminum" by M. S. Hunter and P. Fowle, Aluminum Research Labs., Aluminum Co. of America, New Kensington, Pa. (Abstract No. 43)

2:30 P.M.—"Some Observations Regarding Zinc Anode Corrosion Products" by J. Kruger, O. R. Gates, and M. C. Bloom, Naval Research Lab., Washington, D. C.
(Abstract No. 44)

3:00 P.M.—"High Temperature Corrosion Rates of Several Metals with Nitric Oxide" by Milton Farber, A. J. Darnell, and D. M. Ehrenberg, Jet Propulsion Lab., California Institute of Technology, Pasadena, Calif. (Abstract No. 45)

Electrodeposition

Wednesday, October 12, 1955

Hydrogen Embrittlement

with C. A. Snavely presiding

(ALLEGHENY ROOM)

9:00 A.M.—"The Hydrogen Embrittlement Problem in High Strength Steels" by T. F. Kearns, Bureau of Aeronautics, Navy Dept., Washington, D. C. (Abstract No. 46)

9:30 A.M.—"Mechanism for Hydrogen Entry Into Metals During Chemical and Electrochemical Processing" by L. D. McGraw, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 47)

10:00 A.M.—"Absorption of Hydrogen by Austenite, Ferrite, and Martensite, and Associated Hydrogen Embrittlement" by W. D. Robertson, Hammond Metallurgical Lab., Yale University, New Haven, Conn. (Abstract No. 48)

10:30 A.M.—"Measurements Related to Hydrogen in Metals" by W. E. Ditmars, Jr., and C. B. Griffith, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 49)

11:00 A.M.—"Room Temperature Diffusion of Hydrogen in Annealed and Plastically Deformed Steel" by M. L. Hill and E. W. Johnson, Westinghouse Research Labs., East Pittsburgh, Pa. (Abstract No. 50)

11:30 A.M.—"Hydrogen in Titanium and Titanium Alloys" by G. A. Lenning and R. I. Jaffee, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 51)

12:30 P.M.—Electrodeposition Division Luncheon and Business Meeting in the Fort Duquesne Room (17th floor).

Electrodeposition

Round Table

(ALLEGHENY ROOM)

2:30 P.M.–4:30 P.M.—Round-table discussion on Hydrogen Embrittlement.

Electrodeposition

Thursday, October 13, 1955

with Sydney Barnartt presiding

(ALLEGHENY ROOM)

9:00 A.M.—"Effect of Thickness on Mechanical Processes of Electrodeposited Nickel" by H. J. Read and R. F. Higgs, Dept. of Metallurgy, Pennsylvania State University, University Park, Pa. (Abstract No. 52)

9:30 A.M.—"Direct Determination of the Adhesive Bond Strength of Chromium Electrodeposited on Steel" by W. H. Dancy, Jr., and A. R. Kuhlthau, Ordnance Research Lab., University of Virginia, Charlottesville, Va. (Abstract No. 53)

10:00 A.M.—"A Nucleation Mechanism for Cathodic Polarization at Metallic Electrodes" by T. R. Rubin, Dept. of Chemistry, Ohio State University, Columbus, Ohio. (Abstract No. 54)

10:30 A.M.—"Composite Coatings of Chromium and Nickel for the Protection of Molybdenum Against High Temperature Oxidation" by J.

K. Taylor, Harold Shapiro, and Abner Brenner, Div. of Chemistry, National Bureau of Standards, Washington, D. C. (Abstract No. 55)

11:00 A.M.—"Metallographic Study of Electroplated Coatings of Chromium and Nickel on Molybdenum" by R. J. Runck, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 56)

11:30 A.M.—"Copper Deposit from Sulfate and Cyanide Plating Bath; Investigation by Electron Microscopy" by Shinzo Okada and Saburo Magari, Engineering Research Institute, Kyoto University, Kyoto, Japan. (Abstract No. 57)

12:00 M.—"Electron Microscope Studies on Copper Anodes in Sulfate and Cyanide Baths" by Shinzo Okada, Saburo Magari, and Kentaro Katsui, Engineering Research Institute, Kyoto University, Kyoto, Japan. (Abstract No. 58)

Electronics—Semiconductors

Thursday, October 13, 1955

(MONONGAHELA ROOM)

9:00 A.M.—Ten-minute papers of "late news" type. Program will be available at the registration desk. There will be no abstracts.

Electronics—Semiconductors

(MONONGAHELA ROOM)

2:00 P.M.—Ten-minute papers of "late news" type. Program will be available at the registration desk. There will be no abstracts.

Electro-Organic

Monday, October 10, 1955

with H. M. Scholberg presiding

(MONONGAHELA ROOM)

10:00 A.M.—"Anodic Reactions in the Electrolysis of Lead Formate" by A. N. Kappanna and A. S. Dewagan, College of Science, Nagpur, India. (Abstract No. 59)

10:30 A.M.—"Anodic Oxidation of Certain Carbohydrates" by J. V. Karabinos, Blockson Chemical Co., Joliet, Ill. (Abstract No. 60)

11:00 A.M.—"Electrolytic Reduction of Some Polynuclear Carbocyclic Aromatic Compounds" by G. B. Diamond, 60 Chapel St., Newark, N. J. (Abstract No. 61)

12:30 P.M.—Society Luncheon in the Monongahela Room.

Electro-Organic

with H. M. Scholberg presiding

(MONONGAHELA ROOM)

2:15 P.M.—"Electro-Organic Reduction of 4-Keto-Pimelic Acid to Pimelic Acid" by H. J. Read, Pennsylvania State University, University Park, Pa. (Abstract No. 62)

2:45 P.M.—"Electrolytic Reduction of Amides, II. *p*-Aminobenzanilide and Anisamide" by Sherlock Swann, Jr., J. C. Bresee, and R. A. Strehlow, Dept. of Chemistry and Chemical Engineering, University of Illinois, Urbana, Ill. (Abstract No. 63)

3:15 P.M.—"Electrolytic Reduction of

Cyclic Acid Imides" by Buhei Sakurai, Shinshu University, Matsumoto, Japan. (Abstract No. 64)

3:45 P.M.—"An Improvement for the Electrolytic Preparation of Aminoguanidine" by Motoji Yamashita and Kiichiro Sugino, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan. (Abstract No. 65)

4:15 P.M.—"Electrolytic Reduction of Cyanamide" by Keijiro Odo and Kiichiro Sugino, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan. (Abstract No. 66)

4:45 P.M.—"Mechanism of Electrolytic Reduction of 2-Amino-4-Chloropyrimidines to 2-Aminopyrimidines, and of 2-Aminopyrimidine; An Example of Two Different Types of Electrolytic Reduction" by Kiichiro Sugino, Taro Sekine, and Kozo Shirai, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan. (Abstract No. 67)

Electro-Organic

Tuesday, October 11, 1955

with H. M. Scholberg presiding

(MONONGAHELA ROOM)

9:00 A.M.—"Radicals by Kolbe Electrolysis" by W. H. Urry, Dept. of Chemistry, University of Chicago, Chicago, Ill. (Abstract No. 68)

9:30 A.M.—"Kolbe Electrosynthesis: Effect of Alternating Current, I. Acetic Acid-Potassium Acetate" by C. L. Wilson and W. T. Lippincott, McPherson Chemical Lab., Ohio State University, Columbus, Ohio. (Abstract No. 69)

10:00 A.M.—"Use of a Rotating Cathode in Electrolytic Reduction" by C. L. Wilson and H. V. K. Udupa, McPherson Chemical Lab., Ohio State University, Columbus, Ohio. (Abstract No. 70)

10:30 A.M.—"Cathodic Reduction of *N*-Dimethylaminoethyl Tetrachlorophthalimide" by M. J. Allen and J. Ocampo, Research Dept., Ciba Pharmaceutical Products, Inc., Summit, N. J. (Abstract No. 71)

11:00 A.M.—"Aqueous Kolbe Electrolysis of Mesitoate Ion" by G. W. Thiessen, W. Farr, and B. T. Shawver, Monmouth College, Monmouth, Ill. (Abstract No. 72)

Electro-Organic

with H. M. Scholberg presiding

(MONONGAHELA ROOM)

2:00 P.M.—"Electrochemical Reduction of Nitroguanidine and Related Compounds, I. Behavior of Nitro and Nitrosoguanidine at the Dropping Mercury Electrode" by G. C. Whitnack and E. St. C. Gantz, Analytical Chemistry Branch, U. S. Naval Ordnance Test Station, China Lake, Calif. (Abstract No. 73)

2:30 P.M.—"Polarographic Studies in Acetonitrile and Dimethylformamide, III. Behavior of Quinones and Hydroquinones" by S. Wawzonek, R. Berkey, E. W. Blaha, and M. E. Runner, State University of Iowa, Iowa City, Iowa. (Abstract No. 74)

3:00 P.M.—"Polarographic Behavior of Nitrobenzene in the Solvent Acetonitrile" by M. E. Runner and

G. Balog, Illinois Institute of Technology, Chicago, Ill.

(Abstract No. 75)

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4:00 P.M.—Palladium Medal Address by U. R. Evans, Cambridge, England, in Urban Room.

Electro-Organic

Wednesday, October 12, 1955

with H. M. Scholberg presiding

(MONONGAHELA ROOM)

9:00 A.M.—"Polarographic Reduction of *p*-Hydroxybenzaldehyde" by C. Wheeler, Dept. of Chemistry, University of New Hampshire, Durham, N. H. (Abstract No. 76)

9:30 A.M.—"Polarographic Studies of Some Carbonyl Compounds" by R. A. Day, Jr., Emory University, Emory, Ga. (Abstract No. 77)

10:00 A.M.—"Polarographic Study of Alpha-Keto Acids; Significance of the Wave Separation Resulting from Changes in the *p*H of the Buffer" by O. H. Müller and W. J. P. Neish, Dept. of Physiology, College of Medicine, State University of New York, Syracuse, N. Y. (Abstract No. 78)

10:30 A.M.—"Application of Nonaqueous Polarographic Techniques to the Study of the Kinetics of Peroxidic Reactions" by C. Ricciuti and C. L. Ogg, Eastern Regional Research Lab., Philadelphia, Pa. (Abstract No. 79)

11:00 A.M.—"Oxidation of the Leuco Base of Malachite Green" by M. J. Allen and V. J. Powell, Research

Dept., Ciba Pharmaceutical Products, Inc., Summit, N. J.

(Abstract No. 80)

12:30 P.M.—Electro-Organic Division Luncheon and Business Meeting in Room 735 (7th floor).

Electro-Organic

Round Table

Mechanism of Reduction

with Stanley Wawzonek presiding

(MONONGAHELA ROOM)

2:00 P.M.–5:00 P.M.—Round-table discussion on Mechanism of Reduction. Speakers: S. Swann, Jr., on "Influence of Cathode Materials on Electrolytic Reductions;" C. Wilson on "Mechanism of Reduction of Organic Compounds at a Mercury Cathode;" N. Hackerman on "Influence of Hydrogen Overvoltage on Electrolytic Reduction of Organic Compounds;" P. Elving on "Reduction of Organic Halogen Compounds;" and M. J. Allen on "Mechanism of Reduction of Aldehydes and Ketones to Their Respective Hydrols or Pinacols."

Electrothermics and Metallurgy

Monday, October 10, 1955

Fluidized Solid Techniques

with Robert Toomey presiding

(SKY ROOM)

2:30 P.M.—"Development of the Fluid-Solid Technique" by A. F. Kaulakis, Esso Research and Engineering Co.,

Linden, N. J. (Abstract No. 81)

3:00 P.M.—"Graphical Presentation of Fluids-Solids Dynamics; Fluidized Solids Handling in the Metallurgical Industry" by F. A. Zenz, M. W. Kellogg Co., Jersey City, N. J. (Abstract No. 82)

3:30 P.M.—"Chemical Reactions in Fluidized Beds" by F. M. Stephens, Jr., and L. W. Coffer, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 83)

4:00 P.M.—"Roasting Sulfides in a Fluidized Bed" by R. J. Priestley, Dorr-Oliver, Barry Place, Stamford, Conn. (Abstract No. 84)

Electrothermics and Metallurgy

Tuesday, October 11, 1955

Preparation, Analysis, and Properties of High-Purity Metals

with E. M. Sherwood presiding

(SKY ROOM)

9:30 A.M.—"Modern Technology and High-Purity Metals" by I. E. Campbell, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 85)

10:00 A.M.—"Fusion Electrolysis of Bismuth Trichloride" by Paul Gruzensky, Bureau of Mines, U. S. Dept. of the Interior, Albany, Oreg. (Abstract No. 86)

10:30 A.M.—"Preparation of Pure Nickel by Electrolysis of a Chloride Solution" by W. A. Wesley, Research Lab., International Nickel Co., Bayonne, N. J. (Abstract No. 87)

11:00 A.M.—"Preparation of High-Purity Rhenium" by D. M. Rosenbaum, R. J. Runck, and I. E.

Campbell, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 88)

11:30 A.M.—"Vacuum Melting and Casting of High-Purity Metals" by N. Darmara, Utica Tool and Drop Forge Co., Utica, N. Y.
(Abstract No. 89)

12:30 P.M.—Electrothermics and Metallurgy Division Luncheon, in the Allegheny Room (17th floor).

Electrothermics and Metallurgy

Preparation, Analysis, and Properties of High-Purity Metals (cont'd)

with A. U. Seybolt presiding

(SKY ROOM)

2:00 P.M.—"Floating-Zone Purification of Zirconium" by G. D. Kneip, Jr., and J. O. Betterton, Jr., Union Carbide and Carbon Corp., Oak Ridge National Lab., Oak Ridge, Tenn. (Abstract No. 90)

2:25 P.M.—"Cage Zone Melting" by P. H. Brace and G. Comenetz, Westinghouse Research Labs., East Pittsburgh, Pa. (Abstract No. 91)

2:50 P.M.—"Quality-Control Techniques Employed in the Production of High-Purity Zirconium and Hafnium Metals" by H. L. Kall, Carborundum Metals Co., Inc., Akron, N. Y. (Abstract No. 92)

3:15 P.M.—"Determination of Trace Elements in Metals and Alloys by Radioactivation Analysis" by G. W. Leddicotte and W. A. Brooksbank, Jr., Union Carbide and Carbon Corp., Oak Ridge National Lab., Oak Ridge, Tenn. (Abstract No. 93)

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4:00 P.M.—Palladium Medal Address

by U. R. Evans, Cambridge, England, in the Urban Room.

Electrothermics and Metallurgy

Wednesday, October 12, 1955

Preparation, Analysis, and Properties of High-Purity Metals (cont'd)

with J. R. Musgrave presiding

(SKY ROOM)

9:30 A.M.—"A Study of Separations in the Analysis of High-Purity Metals" by O. R. Gates, Naval Research Lab., Washington, D. C.
(Abstract No. 94)

10:00 A.M.—"Metallographic Techniques" by E. E. Thomas, Bell Telephone Labs., Murray Hill, N. J.
(Abstract No. 95)

10:30 A.M.—"Special Techniques for Analyzing Semiconducting Materials" by J. M. Whelan, Bell Telephone Labs., Murray Hill, N. J.
(Abstract No. 96)

11:00 A.M.—"Preparation and Analysis of High-Purity Tellurium" by S. E. Miller and H. L. Goering, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 97)

Electrothermics and Metallurgy

Preparation, Analysis, and Properties of High-Purity Metals (cont'd)

with B. W. Gonser presiding

(SKY ROOM)

2:00 P.M.—"Ductile Chromium" by W. H. Smith and A. U. Seybolt, Research Lab., General Electric Co., Schenectady, N. Y.
(Abstract No. 98)

2:30 P.M.—"Effect of Impurities on the Hardness of Titanium" by T. D.

McKinley, E. I. du Pont de Nemours & Co., Wilmington, Del.
(Abstract No. 99)

3:30 P.M.—"Effect of Impurities on the Tensile Properties of Aluminum" by A. P. Young, Battelle Memorial Institute, Columbus, Ohio.
(Abstract No. 100)

3:00 P.M.—"Addition of Controlled Amounts of Impurities to a Titanium-Molybdenum Alloy" by S. J. Noesen, General Electric Co., Schenectady, N. Y. (Abstract No. 101)

ABSTRACTS

BATTERY

Abstract No. 1

RESISTIVITY STUDIES OF VARIOUS LECLANCHÉ CATHODE MATERIALS

Richard Glicksman and
C. K. Morehouse

It has been suggested that there is a correlation between dry cell performance and the resistivity of various manganese dioxides. Resistivity data obtained on four types of manganese dioxides over a range of applied pressures up to 100,000 lb/in.^{2} show quite different resistivity vs. applied pressure relationships. These differences, however, are minimized by blending high-resistivity manganese dioxide with low-resistivity Shawinigan acetylene black and electrolyte, and it is concluded that no direct correlation between dry cell performance and resistivity of the manganese dioxide can be made.

Abstract No. 2

A POLARIZATION TECHNIQUE FOR EVALUATING VARIOUS CATHODE MATERIALS

C. K. Morehouse and
Richard Glicksman

A polarization apparatus and technique are described which enable a quick preliminary evaluation to be made of various manganese dioxides and other cathode materials in various electrolytes. Data are presented which show that the reaction of the manganese dioxide electrode during cell

discharge is diffusion-controlled. It is also shown that the structure of the manganese dioxide material is an important property which determines the performance that is obtained when the electrode is discharged, not only in an NH_4Cl-$ZnCl_2$ type electrolyte, but also in a basic electrolyte.

Abstract No. 3

THE ALUMINUM DRY CELL

J. J. Stokes, Jr.

Aluminum dry cells of the familiar Leclanché type show much promise. Discharge characteristics are similar to those of zinc and magnesium cells. The electrolyte is aluminum or chromium chloride inhibited with ammonium or alkali chromates. Best results are obtained with alclad-type anodes which contain an aluminum-zinc alloy and cathodes of MnO_2 and acetylene black. Paper spacers are used instead of flour-starch gels. Storage tests at room temperature indicate shelf life at least comparable to the zinc cell.

Abstract No. 4

AN ELECTRON DIFFRACTION STUDY OF LEAD MONOXIDES

Jeanne Burbank

An electron diffraction study of the lead monoxides indicated the existence of a third form for this compound. A space lattice is suggested, followed by a discussion of its relation to the orthorhombic and tetragonal forms of PbO and to the lattice of pure lead.

Abstract No. 5

OXIDATION OF OXYGEN-FREE HIGH CONDUCTIVITY COPPER

I. Oxidation of Copper to Cu_2O

J. P. Baur, D. W. Bridges, and W. M. Fassell, Jr.

Effect of oxygen pressure on the oxidation behavior of copper was studied at 900° (5–10 mm-Hg), 950° (10–35 mm-Hg), and 1000° C (5–95 mm-Hg) under conditions involving the system $Cu/Cu_2O/O_2$. Weight increase per unit surface area was correlated with time decrement through use of two parallel reaction rates: (*a*) a diffusion-controlled step, and (*b*) a phase boundary reaction. Exception is taken with the unchecked increase of the parabolic rate constant with increased external oxygen pressure seemingly inferred in Wagner's equation, K_p = const. $(P_{O_2})^{1/n}$. Surface site saturation will lead to a cessation of the increase in the parabolic rate constant as the oxygen pressure increases to where the adsorption potential is sufficient to accommodate oxygen on all available surface sites. Photomicrographic study of the growth of CuO on Cu_2O is included.

Abstract No. 6

HIGH PRESSURE OXIDATION OF METALS

Niobium in Oxygen

D. W. Bridges and W. M. Fassell, Jr.

Niobium oxidized linearly in oxygen from 400° to 800°C at oxygen pressures ranging from 14.7 to 605 psia. Wide variations in oxidation rates were observed with variations in oxygen pressure. An equilibrium adsorption process occurs prior to the rate-determining step in the reaction. For niobium it was necessary to include an interaction energy term between the adsorbed oxygen molecules on the adsorption sites to interpret adequately results above 650°C. Orientation of the metal surface apparently influences the interaction energy. Enthalpy of activation was 9,000–10,000 cal/mole (500°–800°C). Enthalpy and entropy of adsorption were −48,550 cal/mole and −52.6 e.u. from 550°–650°C. The interaction energy, zV, varied from 8,300 cal/mole (500°C) to 11,900 cal/mole (800°C).

Abstract No. 7

HIGH PRESSURE OXIDATION OF METALS

Tungsten in Oxygen

J. P. Baur, D. W. Bridges,
and W. M. Fassell, Jr.

Tungsten rod and sheet oxidized linearly in oxygen from 600° to 850°C at oxygen pressures ranging from 20 to 500 psia. Rate of oxidation increased with increased oxygen pressure at temperatures 750°–850°C. Theoretical considerations indicate that an equilibrium adsorption process occurs prior to the rate-determining step in the reaction. Assumption of a linear change of adsorption energy with increase of surface coverage allowed experimentally observed rates of oxida-

tion to be corrected for pressure effect. The activation energy for the oxidation of tungsten (600°–850°C) is 48 kcal. Tungsten oxidation above 900°C was not reported as the metal oxide formed volatilizes. Tungsten sheet volatilization losses were appreciable above 800°C. Only rod data were free from volatilization losses at 850°C.

Abstract No. 8

OXIDATION OF TUNGSTEN

W. W. Webb,* J. T. Norton,
and Carl Wagner

Two oxide layers form during the oxidation of tungsten between 700° and 1000°C. The outer layer is porous, powdery, yellow tungstic oxide WO_3 and the inner layer is a dense, thin, dark blue, tightly adherent oxide of uncertain composition. The oxidation reaction follows initially the parabolic rate law, but eventually there is a transition to the linear rate law. The rate of formation of the inner oxide is presumably inversely proportional to its thickness. The inner oxide seems to transform to the outer oxide at a constant rate. Upon combining the rate laws of the two individual processes, an over-all rate equation covering the whole range is obtained.

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* Allegheny Ludlum Steel Co. Fellow 1953-1955; present address: Metals Research Labs., Union Carbide and Carbon Corp., Niagara Falls, N. Y.

Abstract No. 9

OXIDATION STUDIES IN METAL-CARBON SYSTEMS

W. W. Webb,* J. T. Norton,
and Carl Wagner

A general analysis of the characteristics of the oxidation of alloys containing carbon or carbides is given. Evolution of gaseous CO and CO_2 may rupture oxide films which, in the absence of carbon, are highly protective. On the other hand, if the base metal has a high affinity for oxygen, carbon may be retained in the alloy, or carbon may diffuse across the oxide layer. Experimental data are reported for the systems Ni-C, W-C, Mn-C, and Ti-C.

* Allegheny Ludlum Steel Co. Fellow 1953–1955; present address: Metals Research Lab., Union Carbide and Carbon Corp., Niagara Falls, N.Y.

Abstract No. 10

ROLE OF DISLOCATION IN THE OXIDATION OF METALS

N. Cabrera

(No abstract received)

Abstract No. 11

OXIDATION OF IRON-MOLYBDENUM AND NICKEL-MOLYBDENUM ALLOYS

S. S. Brenner

Binary alloys of iron and molybdenum (up to 12.5 atomic % Mo) and nickel and molybdenum (up to 19.7 at. % Mo) do not exhibit "catastrophic oxidation" up to 1000°C either in stationary or in flowing atmospheres. In both systems, MoO_3 and iron molybdate or nickel molybdate are formed in addition to iron oxides or nickel oxide. Molybdenum significantly decreases the

oxidation rate of iron by preventing formation of the cation deficient FeO normally formed on iron above 570°C. The oxidation rate of nickel, however, is affected only to a small extent. Up to 3 at. % molybdenum, the rate is slightly increased by formation of additional vacancies in the nickel oxide, while beyond 12 at. % the oxidation rate is again decreased owing to the densification of the MoO_2 subscale.

Abstract No. 12

CATASTROPHIC OXIDATION OF SOME MOLYBDENUM-CONTAINING ALLOYS

S. S. Brenner

When nickel or chromium is added to binary iron-molybdenum alloys, catastrophic oxidation occurs in certain concentration regions. Chromium is more effective than nickel in inducing this rapid type of oxidation. Catastrophic oxidation occurs because of the formation of liquid MoO_3 along the metal-oxide interface. This is preceded by the cracking of the chromium or nickel-containing oxide. Catastrophic oxidation does not occur with alloys containing large amounts of nickel.

Abstract No. 13

A SPECTROPHOTOMETRIC STUDY OF THE OXIDATION OF URANIUM

J. T. Waber and G. E. Sturdy

The spectrophotometric method has been used to study the initial stages of the oxidation of uranium. It was observed that corrosion behavior could be described adequately by a logarith-

mic growth law. The energy of activation for the logarithmic rate constant was found to be 4.5 kcal/g-mole. Also, the reflectivity of metallic uranium was measured.

Abstract No. 14

OXIDATION OF IRON-NICKEL ALLOYS

R. T. Foley, J. U. Druck, and R. E. Fryxell

The mechanism of the high temperature (600°–900°C) oxidation of an iron-nickel alloy containing 42% nickel was studied. Reaction products were examined by metallographic and electron diffraction techniques, as well as chemical analyses after stripping.

Temperature dependence of the parabolic oxidation rate constant follows the Arrhenius equation with parameters dependent on the method of surface preparation. The oxide film upon cooling possesses a two-phase structure with a nickel ferrite next to the alloy and Fe_2O_3. Differences in activation energies and oxidation rates are explained by diffusion through ferrite structures ranging from $NiFe_2O_4$ to Fe_3O_4.

Abstract No. 15

REACTION OF HYDROGEN WITH URANIUM

W. M. Albrecht and M. W. Mallett

Reaction rates of hydrogen with uranium follow the linear law in the temperature range 96°–400°C at pressure levels of $p - p_o$ equal to 430, 150, and 70 mm of mercury. Adsorption plays an important role in the over-all

reaction mechanism of uranium with hydrogen. From 96° to about 250°C, adsorption is faster than the reaction to form hydride, but it is of the same order of magnitude. Therefore, formation of hydride is the rate-determining step. From about 250° to 400°C adsorption is probably the rate-controlling step, except for the initial parabolic reaction which would be diffusion controlled.

Abstract No. 16

FORMATION OF POROUS SCALES

C. E. Birchenall

(No abstract received)

Abstract No. 17

PRELIMINARY RESULTS ON THE KINETICS OF THE REACTION OF METALS WITH WATER VAPOR

Paul Blackburn and E. A. Gulbransen

(No abstract received)

Abstract No. 18

OXIDATION STUDIES ON Fe-Cr-Al HEATER ALLOYS

Kenneth Andrew and E. A. Gulbransen

Three studies were made of this alloy system. First, the oxidation of these alloys was studied under constant temperature conditions from 600° to 950°C with no strain present. Second, the oxidation at 900°C was studied before and after a 2% strain. This type of study gives information on the

adhesion of the oxide as it affects the oxidation rate. Third, the composition and crystal structure of the oxide films formed during oxidation were studied by the high temperature electron diffraction method.

Results of these studies showed that the Fe-Cr-Al alloys oxidized faster than the Ni-Cr or Ni-Cr-Fe alloys. However, strain oxidation studies showed the Fe-Cr-Al alloys to be superior.

Abstract No. 19

ACCELERATION OF THE DISSOLUTION OF IRON IN SULFURIC ACID BY FERRIC IONS

H. C. Gatos

Dissolution of iron in H_2SO_4 was studied as a function of Fe^{+++} and H^+ concentration. For a given H_2SO_4 concentration the dissolution rate increases and the hydrogen evolution rate decreases with increasing Fe^{+++} concentration. On the other hand, for a given Fe^{+++} concentration the dissolution rate decreases and the hydrogen evolution rate increases with increasing H_2SO_4 concentration. The presence of Fe^{+++} shifts the electrode potential of iron in H_2SO_4 toward more noble values. An explanation of these phenomena is offered, based on the direct reduction of the Fe^{+++} at the local cathodes in competition with H^+.

Abstract No. 20

DISSOLUTION OF METALS IN AQUEOUS ACID SOLUTIONS

II. Kinetics for the Reactions of Steel

N. M. Komodromos,* A. C. Makrides,** and Norman Hackerman

Dissolution rates of mild steel in acid solutions containing ferric chloride, ceric sulfate, potassium dichromate, benzoquinone, tolu-*p*-quinone, and sodium anthraquinone sulfonate are reported. The effect of stirring velocity, surface roughness, and temperature is given. Results are consistent with the assumption that diffusion of depolarizer to the metal surface is rate limiting.

* Present address: E. I. du Pont de Nemours & Co., Flint, Mich.

** Present address: Institute for the Study of Metals, University of Chicago, Chicago, Ill.

Abstract No. 21

EFFECT OF ALLOYING ELEMENTS IN IRON ON HYDROGEN OVERVOLTAGE AND CORROSION RATE IN ACID ENVIRONMENTS

Milton Stern*

Alloying elements commonly found in steel were added to pure iron to establish their effect on hydrogen overvoltage and corrosion rate in 0.1*M* citric acid (*p*H 2.06), 0.1*M* malic acid (*p*H 2.24), and 4% sodium chloride at *p*H 1 and 2. Sulfur, phosphorus, and carbon proved detrimental to corrosion resistance. Copper and manganese were effective in decreasing the detrimental influence of sulfur. Hydrogen overvoltage data are used to explain the particular influences found for various addition elements.

* Present address: Metals Research Labs., Electro Metallurgical Co., Niagara Falls, N. Y.

Abstract No. 22

DISSOLUTION OF CADMIUM IN CHROMIC CHLORIDE-HYDROCHLORIC ACID SOLUTIONS

C. V. King and Edward Hillner

The dissolution rate of cadmium has been measured in chromic chloride solutions containing hydrochloric acid up to 4M, as a function of concentration, stirring speed, and temperature. In violet solutions, containing the hexaaquo ion, dissolution is slow and chemically controlled; in green solutions of the dichlorotetraaquo ion it is transport-controlled. Reaction with the green ion is rapid in spite of a driving force of only a few millivolts. The potential of the metal in these solutions is essentially that of the cadmium-cadmium ion couple, and there is little if any anodic polarization.

Abstract No. 23

ROLE OF HYDROGEN IN CORROSION REACTIONS

J. E. Draley and W. E. Ruther

Hydrogen produced during aqueous corrosion can influence the course of the reaction. Diffusion into the metal causes high stress concentrations, sometimes resulting in cracking or blistering. Formation of hydrogen gas beneath the protective barrier film can cause film rupture and accelerated corrosion. In the corrosion of certain hydride-forming metals, metal hydride is believed to form beneath the barrier film, destroying its adherence to the metal and reducing its protective

properties. A number of unusual effects, such as anodic protection, are explainable in these terms.

Abstract No. 24

A STUDY OF THE CATHODIC REDUCTION OF OXIDE FILMS ON IRON

I. Reduction of Alpha-Fe_2O_3 Films

H. G. Oswin and M. Cohen

The apparatus and technique for the cathodic reduction of alpha-Fe_2O_3 films is described. Measurements of the efficiency of the reduction in buffered and unbuffered electrolytes are given. Effects of *p*H of the electrolyte, dissolved oxygen, current density, and film thickness are noted and discussed. Electrolytes containing "ferrous-complexing" ions have also been investigated. Methods of determining quantities of alpha-Fe_2O_3 in thin films are suggested and their limits of accuracy considered.

Abstract No. 25

KINETICS OF EXCHANGE BETWEEN SOLID COPPER AND SILVER IONS IN AQUEOUS SOLUTIONS

M. Simnad, A. Spilners, and Ling Yang

Rates of electrochemical exchange between solid copper specimens and silver ions in solutions have been studied. The effect of various factors, such as temperature, ionic concentration, and surface structure on the rate of exchange has been determined. Distribution of the exchanged ions on

the metal surface is demonstrated by means of autoradiographs and by microscopic examination.

Abstract No. 26

A STUDY OF THE EFFECT OF CHLORIDE ION ON FILMS FORMED ON IRON IN SODIUM NITRITE SOLUTIONS

G. W. Mellors, M. Cohen, and F. Beck

The effect of chloride ion on the potential of iron in sodium nitrite solutions has been measured, and related to surface composition and topography by electron diffraction and electron microscopy. The effect of initial surface preparation has also been investigated. It was shown that in the absence of chloride ion the potential is noble and steady and that the surface remains practically unchanged. A film of γ-Fe_2O_3 is shown to be present by electron diffraction. When chloride ion was added to the system the potential became unsteady and less noble. Inclusions of a second phase grew in the oxide layer. This proved to be hydrated γ-Fe_2O_3 or lepidocrocite.

Abstract No. 27

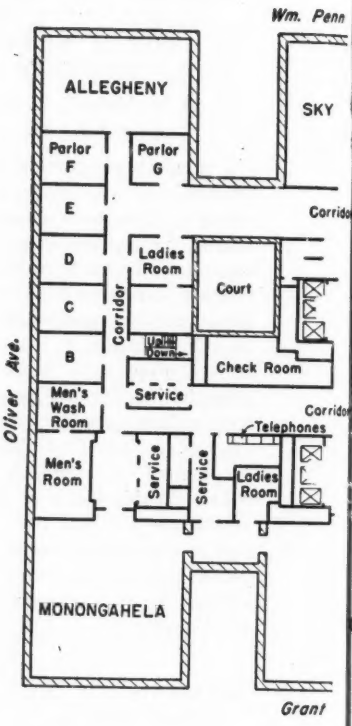
MECHANISM OF THE HYDROGEN EVOLUTION REACTION ON SILVER AND TUNGSTEN CATHODES

J. O'M. Bockris

(No abstract received)

Abstract No. 28

OXYGEN ADSORPTION ON STAINLESS STEEL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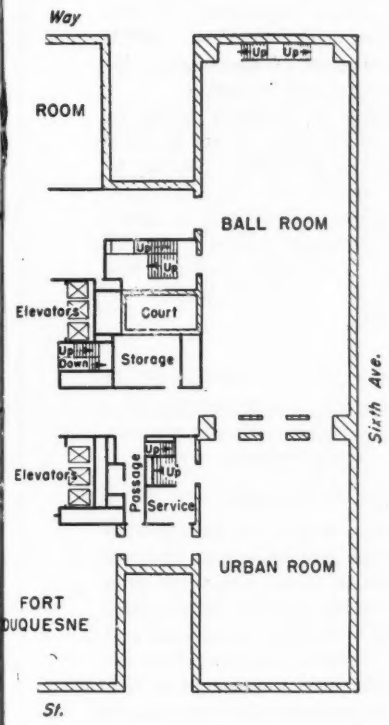
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URBAN ROOM
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T. N. Rhodin, Jr.

Chemisorption of oxygen occurs on deoxidized stainless steel at −195°C with very low energies of activation and high heats of adsorption. The amount and mechanism of adsorption show a unique dependence on the temperature from −195° to 100°C. The effectiveness of the original deoxidation treatment is critical.

Conversion of adsorbed layers to ultrathin oxide films occurs at temperatures from 0° to 30°C. Contrary to previous reports in the literature, chemisorption equivalent to a monolayer on a deoxidized surface or physical adsorption of 10 layers does not passivate the surface to 1*N* H_2SO_4 solution at 25°C.

Abstract No. 29

ELECTRICAL PROPERTIES OF THE OXIDE FILM ON ZIRCONIUM

R. D. Misch

A three-wire probe is employed to measure the electrical conductivity of thin oxide films on zirconium as a function of temperature. Anodic films from 1000 to 10,000 Å in thickness and natural corrosion films have been examined. Conduction begins at a well-defined temperature which depends on film thickness. Upon further slow heating, the current through the film rises rapidly and exponentially. Specimens can be cycled repeatedly into the conduction range, but often show permanent electrical breakdown. Curves of temperature of conduction vs. film thickness are a function of the base metal and the method of film prepara-

tion. The significance of these factors for gas-metal oxidation theory is discussed.

Abstract No. 30

ORTHOPHOSPHATES OF IRON, MANGANESE, AND ZINC

Jeanne Burbank

Iron, manganese, and zinc orthophosphates most likely to be encountered in phosphating processes and coatings were synthesized, and their x-ray diffraction patterns established. The solution rate of steel in phosphoric acid was determined as a function of time, temperature, and acid concentration.

Abstract No. 31

INFLUENCE OF SPECIMEN AREA ON THE PITTING PROBABILITY OF ALUMINUM

P. M. Aziz and H. P. Godard

The pitting probability of 2S aluminum was determined in Kingston tap water as a function of area, for areas ranging in size from 0.06 cm^2 to 243 cm^2. The pitting probability was found to vary uniformly with area from 0.001 to 1 as the area increased from 0.06 cm^2 to 60 cm^2; extrapolation indicated that the pitting probability becomes zero at an exposed area of about 0.055 cm^2. This work supports the contention that pitting sites in aluminum are not specific macrodefects in the metal surface, but rather arise in a random fashion through the interaction of myriads of anodic and cathodic elements on the metal surface.

Abstract No. 32

PITTING CORROSION OF 18 Cr-8 Ni STAINLESS STEEL

I. Development of Accelerated Electrolytic Pit Initiation Methods

M. A. Streicher

(No abstract received)

Abstract No. 33

PITTING CORROSION OF 18 Cr-8 Ni STAINLESS STEEL

II. Investigation of Variables in the Metal and in the Electrolyte Which Control Pit Initiation

M. A. Streicher

(No abstract received)

Abstract No. 34

DETERMINATION OF CORROSION RATES IN AQUEOUS SYSTEMS AT ELEVATED TEMPERATURE AND PRESSURE BY A HYDROGEN EFFUSION METHOD

M. C. Bloom and M. Krulfeld

A technique is described in which the corroding solution, sealed in a thin-walled capsule of the metal under test, is inserted in a glass system of known volume. After evacuation of the system, the capsule is dropped in a heated section and the hydrogen, generated by corrosion, permeates the capsule walls. Hydrogen collects in the glass system where its pressure is continuously recorded, giving a record of the corrosion reaction.

Abstract No. 35

GALVANIC CORROSION CHARACTERISTICS OF ALUMINUM ALLOYS

M. J. Pryor and D. S. Keir

Current flow and polarization data have been determined for aluminum-steel, zinc-steel, aluminum-copper, and aluminum-zinc couples in sodium chloride solutions. The effect of anode and cathode areas and the effect of stirring have been studied for the aluminum-steel and zinc-steel couples in similar solutions. Some of the factors,controlling rates of galvanic corrosion are suggested.

Abstract No. 36

CRYSTALLIZATION OF ANODIC TANTALUM OXIDE FILMS IN THE PRESENCE OF A STRONG ELECTRIC FIELD

D. A. Vermilyea

Crystallization of amorphous anodic oxide films on tantalum may be accomplished by holding at temperatures in the neighborhood of room temperature, provided a strong electric field is present in the film. Such crystallization results in crystalline areas consisting of pie-shaped polycrystalline segments surrounded by coiled-up cylinders of the replaced amorphous phase. Factors affecting the nucleation and growth of these areas are discussed, and a mechanism of growth is proposed. Nucleation of the areas is not understood at present.

Abstract No. 37

VARIOUS FACTORS AFFECTING THE FORMATION OF ANODIC

OXIDE COATINGS IN SULFURIC ACID ELECTROLYTES

R. B. Mason

Factors affecting the solubility of the coatings, such as had developed within the coating and time of immersion, have been investigated. Rapid changes in current and voltage, which occur in the first 15 sec after the current is turned on, give certain clues as to the possible mechanism of pore formation. The amount of sulfate found in anodic coatings formed on pure aluminum anodes in sulfuric acid electrolytes increased as the current density and concentration of acid increased, but decreased as the temperature was raised. Chemical analysis showed that the coatings consisted substantially of Al_2O_3 and SO_3 with practically no water.

Abstract No. 38

ELECTROCHEMICAL STUDIES OF ALUMINUM CORROSION IN WATER

Manuel Shaw and S. B. Twiss

A technique for measuring corrosion current is outlined, and its relationship to the effect of *p*H, chloride ion concentration, and additives on the corrosion or corrosion inhibition of aluminum is determined. Comparison of various natural waters indicates that large corrosion currents exist when the *p*H is greater than 10; below this value, corrosion of aluminum is determined primarily by chloride ion concentration. A large number of compounds are screened and classified according to current range as to their efficiency as inhibitors or stimulators of corrosion of alclad aluminum.

Abstract No. 39

ANODIC POLARIZATION OF ZIRCONIUM AT LOW POTENTIALS

Formation Rates, Formation Field, Electrolytic Parameters, and Film Thicknesses of Very Thin Oxide Films

G. B. Adams, Jr., Mario Maraghini, and Pierre Van Rysselberghe

Working below oxygen evolution potentials, the above quantities were evaluated from anodic potential-time measurements. Results obtained are shown to be internally consistent, and are in agreement with those found by others for anodic oxide films formed on zirconium in the high potential range.

Correlation is established between these results and the authors' previously reported work on the estimation of local currents from anodic potential-time measurements.

All results have been interpreted on the assumption of true oxide film growth below oxygen evolution potentials.

Abstract No. 40

ELECTROCHEMICAL THERMODYNAMICS OF J. WILLARD GIBBS AND THE STOCKHOLM CONVENTIONS

The Gibbs-Stockholm Electrode Potential

A. J. de Béthune

The electrode potential, defined by Gibbs' expression $V = V_m - V_s$, remains sign invariant upon the reversal of an infinitesimal current flow, while the half-cell emf E changes sign. For

the potential of a metallic electrode, Gibbs writes $V_m - V_s = (RT/n_m\gamma)$ ln γ/G where γ is the density of the metal ions in solution, and G is analogous to Nernst's "metal solution pressure." In terms of the sign-invariant Gibbs-Stockholm electrode potential V, the free enthalpy is $F = +nV$ for anodic oxidations and $F = -n\gamma V$ for cathodic reductions. This makes V a measure of the oxidizing power of oxidizing agents. A positive V may be referred to as a galvanic "reduction" or "cathodic" potential, and as an electrolytic "oxidation" or "anodic" potential.

Abstract No. 41

ELECTROCHEMICAL POTENTIALS OF GRAINS AND GRAIN BOUNDARIES IN COPPER SOLID SOLUTIONS

R. Bakish and W. D. Robertson

Irreversible potentials of grains and grain boundaries were measured in pure copper, Cu_3Au, and in alpha brass; the three cases represent the structural grain boundary in a pure metal, an alloy in which only one component is oxidized, and an alloy in which both components are oxidized. Potentials were measured in ferric chloride and in aqueous ammonia, the former representing an electrolyte in which only Cu_3Au is susceptible to stress cracking, and the latter representing conditions in which brass is susceptible to stress cracking.

Abstract No. 42

EFFECT OF FLUORIDES AND OTHER ADDITION AGENTS ON THE CATHODIC POTENTIAL OF TITANIUM IN HYDROFLUORIC ACID

M. E. Straumanis, S. T. Shih, and A. W. Schlechten

Cathodic potentials of Ti in HF become more negative with the addition of alkali fluorides to the acid. The effect increases with the concentration of the salt and in the sequence $NH_4F \rightarrow KF \rightarrow NaF$, which is also the sequence of decreasing cationic radius. If the Ti cathode dissolves in the acid, the cathodic potential-current density relationship is linear; if the dissolution ceases (at higher concentrations of the added fluoride), Tafel's relationship is fulfilled. In between there is a mixed straight line and quasi logarithmic relationship, the latter occurring at higher current densities.

Abstract No. 43

NATURAL AND THERMALLY FORMED OXIDE FILMS ON ALUMINUM

M. S. Hunter and P. Fowle

Structure and rate of formation of natural and thermally formed oxide films on aluminum are discussed. It is shown that these films consist of a layer of barrier-type oxide, the thickness of which is primarily a function of temperature, and a porous layer, the thickness of which is determined by time and natural forces associated with the environment. Effects of temperature and environment on the formation rate and ultimate thickness of these layers are described.

Abstract No. 44

SOME OBSERVATIONS REGARDING ZINC ANODE CORROSION PRODUCTS

J. Kruger, O. R. Gates, and M. C. Bloom

Zinc as a galvanic anode in sea water has been plagued by the formation of insoluble products. Improved behavior has been demonstrated for low iron content (<0.0015%) anodes. Experiments are described pointing to the formation of adherent grain boundry material in the zincs of higher iron content as the offender. X-ray diffraction studies which give clues to the nature of this material are described.

Abstract No. 45

HIGH TEMPERATURE CORROSION RATES OF SEVERAL METALS WITH NITRIC OXIDE*

Milton Farber, A. J. Darnell, and D. M. Ehrenberg

An experimental study has been made of the high temperature corrosion rates of various metal filaments with nitric oxide. Corrosion rates have been determined for iron, tantalum, tungsten, molybdenum, nickel, copper, silver, and the alloys Inconel,** and stainless steel. Temperature range included temperatures from 800°–2000°K. Metals in order of decreasing corrosion resistance are Inconel, 25-20 stainless steel,

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* This paper presents the results of one phase of research carried out at the Jet Propulsion Laboratory under Contract No. DA-04-495-Ord 18, sponsored by the Department of the Army, Ordnance Corps.

** Inconel is registered trade mark of the International Nickel Company.

molybdenum, nickel, tantalum, 18-8 stainless steel, tungsten, iron, and copper.

ELECTRODEPOSITION

Abstract No. 46

THE HYDROGEN EMBRITTLEMENT PROBLEM IN HIGH STRENGTH STEELS

T. F. Kearns

The significance of the hydrogen embrittlement problem is developed on the basis of requirements primarily for aircraft for use of steels at very high strength levels. The pertinent fabrication processes and the sources of hydrogen are indicated and current methods of alleviating hydrogen damage are outlined. Data are presented on the relationship between stresses and hydrogen damage in steels at the 260 to 280,000 psi strength level. Fabrication processes which result in residual tensile stresses at the surface are serious complicating factors in hydrogen embrittlement of steels at this strength level in view of the low tempering temperatures required and the consequent inability to relieve residual stresses.

Abstract No. 47

MECHANISM FOR HYDROGEN ENTRY INTO METALS DURING CHEMICAL AND ELECTROCHEMICAL PROCESSING

L. D. McGraw

Proposed mechanisms for entry of hydrogen into metals are reviewed in terms of the experimental evidence

supporting them. The possibilities that lattice defects, catalysis, hydride formation, and diffusion rate influence the permeability of metals to hydrogen are taken into consideration. The relation of hydrogen overvoltage phenomena to possible hydride formation, chemisorption of hydrogen, and rate of recombination of atomic hydrogen is discussed.

Abstract No. 48

ABSORPTION OF HYDROGEN BY AUSTENITE, FERRITE, AND MARTENSITE, AND ASSOCIATED HYDROGEN EMBRITTLEMENT

W. D. Robertson

The absorption and permeation rate of hydrogen in various steel structures has been determined. The delayed fracture of steel has been investigated as a function of measured hydrogen content, stress, time, and structure.

Abstract No. 49

MEASUREMENTS RELATED TO HYDROGEN IN METALS

W. E. Ditmars, Jr., and C. B. Griffith

Techniques used at present are briefly reviewed, including measurements on: (*a*) hydrogen entry; (*b*) hydrogen content of the metal; (*c*) form of hydrogen in the metal; and (*d*) hydrogen influenced changes in the properties of the metal. Iron and steels are emphasized. Measurements most satisfactory for studying particular types of problems are discussed. Problem areas where present techniques appear to give ambiguous answers are mentioned.

Abstract No. 50

ROOM TEMPERATURE DIFFUSION OF HYDROGEN IN ANNEALED AND PLASTICALLY DEFORMED STEEL

M. L. Hill and E. W. Johnson

The room temperature diffusivity, D, of hydrogen in annealed iron was determined from rates of hydrogen evolution from homogeneously charged cylinders. The result, 2.1×10^{-7} cm²/sec, is some 60 times a previous experimental value, but only 1% of other published values as obtained by extrapolation from above 350°C.

Plastic deformation greatly reduces the bulk diffusivity. Thus, hydrogen-charged, prestrained tensile test specimens retained their hydrogen, and hence their embrittlement, during aging sufficiently to eliminate the hydrogen from unstrained material. With heavier cold working diffusion apparently ceased altogether below 200°C.

Abstract No. 51

HYDROGEN IN TITANIUM AND TITANIUM ALLOYS

G. A. Lenning and R. I. Jaffee

An understanding of the effects of hydrogen in titanium and titanium alloys is important because of its embrittling action. Unalloyed titanium and titanium alloys containing alpha-stabilizing additions, such as aluminum, are most subject to hydrogen embrittlement at impact speeds in the presence of a notch. On the other hand, alpha-beta-type alloys containing beta-stabilizing elements, such as manganese,

are most subject to embrittlement at slow test speeds.

Mechanical-property tests and failures in service have demonstrated the desirability of maintaining low hydrogen levels in titanium materials. To this end, sources of hydrogen contamination in extraction, melting, and processing of titanium materials have received intensive study recently.

Abstract No. 52

EFFECT OF THICKNESS ON MECHANICAL PROPERTIES OF ELECTRO DEPOSITED NICKEL

H. J. Read and R. F. Higgs

Tensile strengths and ductilities were determined by means of the hydraulic bulge test on nickel deposits ranging in thickness from 0.3 to 3 mils, prepared from Watts, nickel-chloride, and nickel-fluoborate baths. Thickness has very little effect on the tensile strength of the deposits, but the ductility as measured by significant strain at fracture decreases with decreasing thickness of nickel.

Abstract No. 53

DIRECT DETERMINATION OF THE ADHESIVE BOND STRENGTH OF CHROMIUM ELECTRODEPOSITED ON STEEL*

W. H. Dancy, Jr., and A. R. Kuhlthau

Small chromium plated rotors have been suspended in a magnetic field and accelerated until the centrifugal forces

* This work was supported by the U. S. Army Ordnance through the Watertown Arsenal Laboratories.

acting on the plate cause it to be torn from the hardened steel base metal. A knowledge of the size of the rotor, the thickness and density of the coating, and the speed of the rotor at failure allows one to compute directly the maximum stress imposed on the adhesive bond. Tests have been made to determine the effect of plate thickness on the bond strength and to determine the reduction in bond strength caused by various contaminants introduced on the surface of the base metal prior to plating.

Abstract No. 54

A NUCLEATION MECHANISM FOR CATHODIC POLARIZATION AT METALLIC ELECTRODES

T. R. Rubin

An electrolysis mechanism for nickel and copper reduction based on nucleation of metal surfaces has been developed through a correlation of rate effects and potential current effects by means of the diffusion equation with drift. The process appears to cause a surface diffusion of charge originating from the point of nucleation. Charge effects appear to be localized within dimensions corresponding to the size of the water-ion coordination polyhedra found in the crystalline hydrates of copper sulfate pentahydrate and nickel sulfate hexahydrate. Nuclei appear to be composed of disordered atoms similar to that found in liquids. Intersurface tensions for the nuclei have been computed. Spontaneous spreading of nuclei over the metal surfaces occurs at higher potentials.

Abstract No. 55

COMPOSITE COATINGS OF CHROMIUM AND NICKEL FOR THE PROTECTION OF MOLYBDENUM AGAINST HIGH TEMPERATURE OXIDATION

J. K. Taylor, Harold Shapiro, and Abner Brenner

Techniques are described for obtaining adherent deposits of chromium and nickel on molybdenum. Data on the protective value of chromium-nickel composite coatings for the temperature range 1800°–2000°F are presented and evaluated. It appears that more than 0.002 in. thickness of nickel over 0.001 in. of chromium is required to offer significant periods of protection at temperatures of 1800°F and higher. On the other hand, 2200°F has been established as an upper limit of temperature beyond which no prolonged protection of molybdenum can be expected from chromium-nickel coatings about 0.01 in. thick.

Abstract No. 56

METALLOGRAPHIC STUDY OF ELECTROPLATED COATINGS OF CHROMIUM AND NICKEL ON MOLYBDENUM

R. J. Runck

Single-layer and multiple-layer coatings on molybdenum of electroplated nickel and chromium were studied metallographically to determine causes of failure of these coatings when heated in air. In single-layer coatings, chromium was found to be less subject to bonding failure than nickel and to afford better protection against oxida-

tion. Cracking of chromium coatings was probably a major cause of failure, but good protection by chromium was possible if a layer of chromium-molybdenum alloy was developed at the interface. Multiple-layer coatings of chromium and nickel in which chromium formed the initial layer may be superior to single-layer coatings, but the formation of blisters between the layers of chromium and nickel was a major cause of failure of this type of coating.

Abstract No. 57

COPPER DEPOSIT FROM SULFATE AND CYANIDE PLATING BATH

Investigation by Electron Microscopy

Shinzo Okada and Saburo Magari

The copper deposit from sulfate and cyanide bath at lower current densities is described. The unevenness of the deposit occurs on various kinds of copper electrodes at lower current densities. To clarify the unevenness of the deposit, several experiments were undertaken. From these experiments it was confirmed that the crystal structure of the base metal has a deep influence on the unevenness of the deposit. From precise observation it was found that the unevenness of the deposit goes on regularly. The deposit on one crystal has but one feature all over the crystal. This feature differs from the plating bath. That is, the planes which are parallel to (010) planes and (101) planes of the base crystal develop in sulfate copper plating bath, and the planes which are parallel to (130) planes of the base crystal develop in cyanide copper plating bath.

Abstract No. 58

ELECTRON MICROSCOPE STUDIES ON COPPER ANODES IN SULFATE AND CYANIDE BATHS

Suinzo Okada, Saburo Magari, and Kentaro Katsui

Copper anodes in sulfate and cyanide baths, at low current densities, dissolve regularly. The crystal structure of the base metal has a profound influence on the solution, which is characteristic for a given single crystal anode, and does not differ for the two different electrolytes. 012 planes of the base crystal develop in both copper plating baths and, in etching solutions for metallography, the same planes of the base crystal also develop.

ELECTRO-ORGANIC

Abstract No. 59

ANODIC REACTIONS IN THE ELECTROLYSIS OF LEAD FORMATE

A. N. Kappanna and A. S. Dewagan

The electrolysis of lead formate at platinum and gold anodes yields only lead dioxide when conducted below a limiting current density. Current yields and potentials are predictable within this range. Effects of additions of alkali formates and free formic acid are reported. New products appear at higher current densities.

Abstract No. 60

ANODIC OXIDATION OF CERTAIN CARBOHYDRATES

J. V. Karabinos

(No abstract received)

Abstract No. 61

ELECTROLYTIC REDUCTION OF SOME POLYNUCLEAR CARBOCYCLIC AROMATIC COMPOUNDS

G. B. Diamond

A new series of polynuclear carbocyclic aromatic compounds has been reduced electrolytically in high yield. In the case of the naphthyl ethers, the new series further demonstrates the efficacy of the method, and in the specific case of 1-methyl-2-methoxy naphthalene the enhanced selectivity of the electrolytic method as compared to the chemical method is strikingly illustrated. The feasibility of the method for the reduction of unsubstituted polynuclear carbocyclic aromatic compounds is demonstrated for the cases of naphthalene and phenanthrene.

Abstract No. 62

ELECTRO-ORGANIC REDUCTION OF 4-KETO-PIMELIC ACID TO PIMELIC ACID

H. J. Read

Electroreduction of 4-keto-pimelic acid to pimelic acid in aqueous sulfuric acid solutions at cadmium cathodes at 60°C gives yields of about 75% or higher with little undesirable by-product formation. Solubility data for reactants and products in water and in various

concentrations of sulfuric acid were determined so that suitable conditions for continuous operation of the process could be predicted.

Abstract No. 63

ELECTROLYTIC REDUCTION OF AMIDES

II. *p*-Aminobenzanilide and Anisamide

Sherlock Swann, Jr., J. C. Bresee, and R. A. Strehlow

The electrolytic reduction of *p*-aminobenzanilide has been studied in sulfuric acid solutions at cathodes of zinc, cadmium, mercury, lead, aluminum, tin, bismuth, copper, iron, and cobalt. The starting material was not reduced at any cathode. A similar study was carried out of the electrolytic reduction of anisamide to *p*-methoxybenzylamine at the same metals as cathodes with the addition of nickel. Lead, cadmium, and zinc were active. The best and most consistent yields were obtained at lead.

Abstract No. 64

ELECTROLYTIC REDUCTION OF CYCLIC ACID IMIDES

Buhei Sakurai

One of the two carbonyl groups which are contained in the compounds belonging to this series was easily reducible to methylene electrolytically or purely chemically, but the other one could not be reduced to the same form. The author succeeded in achieving this object by using a zinc-amalgam electrode as cathode. The main compounds used for this purpose were phthalimide, naphthalimide, succinimide, glutarimide, camphoric acid imide, and their derivatives.

Abstract No. 65

AN IMPROVEMENT FOR THE ELECTROLYTIC PREPARATION OF AMINOGUANIDINE

Motoji Yamashita and Kiichiro Sugino

Nitroguanidine was reduced to aminoguanidine at lead and iron cathodes. By operating in an ammonium salt catholyte instead of one containing free sulfuric acid, yields of 80% of theoretical, and better, were obtained instead of the usual 50–60%. Increased stability of the intermediate nitrosoguanidine in the medium of higher *p*H is assumed to be the reason back of the improved yields.

Abstract No. 66

ELECTROLYTIC REDUCTION OF CYANAMIDE

Keijiro Odo and Kiichiro Sugino

Conversion of cyanamide to methylamine by cathodic reduction through hydrogen cyanide, previously recorded, could not be verified satisfactorily. However, cyanamide could be cathodically reduced to methylamine by way of formamidine in an ammonium sulfate-sulfuric acid catholyte.

Abstract No. 67

MECHANISM OF ELECTROLYTIC REDUCTION OF 2-AMINO-4-CHLOROPYRIMIDINES TO 2-AMINOPYRIMIDINES, AND OF 2-AMINOPYRIMIDINE

An Example of Two Different Types of Electrolytic Reduction

Kiichiro Sugino, Taro Sekine, and Kozo Shirai

By combining polarography with macro electrolysis and conventional identification of organic products, it was shown that certain halogenated derivatives of aminopyrimidine could have their halogens replaced by hydrogen, and that this could be followed by the electrolytic hydrogenation of the Kekule bonds within the nucleus.

Abstract No. 68

RADICALS BY KOLBE ELECTROLYSIS

W. H. Urry

(No abstract received)

Abstract No. 69

KOLBE ELECTROSYNTHESIS: EFFECT OF ALTERNATING CURRENT

I. Acetic Acid-Potassium Acetate

C. L. Wilson* and W. T. Lippincott

Kolbe electrosynthesis with acetate systems in aqueous and nonaqueous solvents was conducted with 60-cycle a.c. Products are similar to those from direct current, but yields are lower and the critical current density higher. Results of varying current density, temperature, and acetate concentration are reported, as are results of adding varying reagents. A practical ethane synthesis based on this procedure is offered.

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* Present address: Hudson Foam Plastics Corp., Yonkers, N. Y.

Abstract No. 70

USE OF A ROTATING CATHODE IN ELECTROLYTIC REDUCTION

C. L. Wilson* and H. V. K. Udupa**

The effect of rotation of the cathode on the current efficiency of reduction on some unsaturated acids and carbonyl compounds was found to be favorable always. In some cases, the relative yield of bimolecular reduction compound to monomolecular was also increased. These results are explained on the assumption that diffusion to the electrode is a rate-determining step.

* Present address: Hudson Foam Plastics Corp., Yonkers, N. Y.

** Present address: Central Electrochemical Research Institute, Alagappa College, Karaikidi, India.

Abstract No. 71

CATHODIC REDUCTION OF *N*-DIMETHYLAMINOETHYL TETRACHLOROPHTHALIMIDE

M. J. Allen and J. Ocampo

It has been found that *N*-dimethylaminoethyl tetrachlorophthalimide can be reduced electrolytically to the respective isoindoline at high overpotential electrodes. Chemical methods, as well as previously described conditions used for the electrolytic reduction of other imides, were found unsatisfactory. Conditions used for the preparation of the isoindoline and results obtained at various electrodes studied using constant current density will be described. A comparison will be made between the efficiency obtained using constant current density and controlled potential electrolysis.

Abstract No. 72

AQUEOUS KOLBE ELECTROLYSIS OF MESITOATE ION

G. W. Thiessen, W. Farr, and B. T. Shawver

The well-known peculiarities of this acid, compared to benzoic acid, led to the prediction of possibility of its aqueous electrolysis and extensive discharge of its ion in competition with hydroxide. This prediction was fulfilled. The products are being studied. Insight has been gained into the nature of benzenoid inhibition.

Abstract No. 73

ELECTROCHEMICAL REDUCTION OF NITROGUANIDINE AND RELATED COMPOUNDS

I. Behavior of Nitro and Nitrosoguanidine at the Dropping Mercury Electrode

G. C. Whitnack and E. St. C. Gantz

Polarographic half-wave potentials and diffusion currents for both compounds were studied under various alkaline and acid conditions. Different mechanisms are postulated for basic and acid reductions. Optimum *p*H conditions are specified, with other details, both for determination of the nitroso compound in presence of the nitro compound, and for the reduction of the nitro compound to the nitroso one.

Abstract No. 74

POLAROGRAPHIC STUDIES IN ACETRONITRILE AND DIMETHYLFORMAMIDE

III. Behavior of Quinones and Hydroquinones

S. Wawzonek, R. Berkey, E. W. Blaha, M. E. Runner

Quinones in the above solvents are reduced stepwise to semiquinone anion and hydroquinone dianion. Addition of an appropriate proton source changes the reduction to a one-step process. Presence of the dianion was demonstrated for anthraquinone by macroelectrolysis. 2-Methyl-1,4-naphthohydroquinone resisted polarographic and chemical oxidation in the above anhydrous solvents, but yielded in the presence of water.

Abstract No. 75

POLAROGRAPHIC BEHAVIOR OF NITROBENZENE IN THE SOLVENT ACETONITRILE

M. E. Runner and G. Balog

Nitrobenzene, azobenzene, asoxybenzene, phenylhydroxylamine, and *o*-nitroaniline were polarographed in acetonitrile, at about millimolar concentrations, at 25°C, in presence of 0.1M tetrabutylammonium iodide. A mercury-pool anode was used. Double-wave polarograms always resulted. The second wave always equalled or exceeded the first, and was altered by addition of water. A one-electron initial reduction step is postulated, as for quinones. An interpretation is offered.

Abstract No. 76

POLAROGRAPHIC REDUCTION OF *p*-HYDROXYBENZALDEHYDE

C. Wheeler

Polarographic data for *p*-hydroxybenzaldehyde in well-buffered aqueous and 50% alcoholic solution are offered. One wave appears at low or high *p*H, but two for intermediate values. These *p*H's change with changing solvents, as does the half-wave potential. The mechanism postulated, like that for benzaldehyde, requires protonated aldehyde as an intermediate. The reaction proceeds through the dihydroxyhydrobenzoin to the hydroxybenzyl alcohol.

Abstract No. 77

POLAROGRAPHIC STUDIES OF SOME CARBONYL COMPOUNDS

R. A. Day, Jr.

Benzaldehydes and benzophenones with diverse substituents were polarographed in buffered water-ethanol solutions. These altered the normal carbonyl reduction characteristics in a manner consistent with assumption of metal ketyl intermediates. Phenyl-substituted acetones in dioxane-tetraalkylammonium systems were likewise studied. Varying behaviors were found and are explained on a steric basis.

Abstract No. 78

POLAROGRAPHIC STUDY OF ALPHA-KETO ACIDS; SIGNIFICANCE OF THE WAVE SEPARATION RESULTING FROM CHANGES IN THE *p*H OF THE BUFFER

O. H. Müller and W. J. P. Neish

Polarographic reduction of alpha-keto acids shows, in general, two waves of about equal total height, merging into one at sufficiently low *p*H. One theory

explains this in terms of tautomerism, another in terms of differential reduction of the free acid and its anion. Neither theory is wholly consistent with all facts. A new explanation is offered, on the basis of a series of polarographic studies of alpha-keto acids and related compounds.

Abstract No. 79

APPLICATION OF NONAQUEOUS POLAROGRAPHIC TECHNIQUES TO THE STUDY OF THE KINETICS OF PEROXIDIC REACTIONS

C. Ricciuti and C. L. Ogg*

Peracid-unsaturated fatty acid ester reactions were polarographed in ammonium acetate-acetic acid, and hydroperoxide decompositions in lithium chloride-methanol-benzene. Peracid and hydroperoxide were estimated reliably and directly. Kinetic constants and rate orders were deduced, and correlated with locations of unsaturation.

* Eastern Regional Research Laboratory is part of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Dept. of Agriculture.

Abstract No. 80

OXIDATION OF THE LEUCO BASE OF MALACHITE GREEN

M. J. Allen and V. J. Powell

The oxidation of the leuco base of malachite green has been investigated polarographically at a rotating platinum electrode. It was found that in an acidic buffer medium the leuco base underwent a one-electron change to form a rather stable triphenylmethane-type free radical. There was no apparent

shift in half-wave potential and a linear relationship was obtained between concentration and diffusion current in the range of concentrations studied.

ELECTROTHERMICS AND METALLURGY

Abstract No. 81

DEVELOPMENT OF THE FLUID-SOLID TECHNIQUE

A. F. Kaulakis

The fluid-solid technique is one of the most interesting chemical engineering developments of the past 20 years. The history behind its development is given. In addition, principles involved in applying the fluid-solid concept to industrial processes are reviewed. Fluid-bed density, entrainment, heat transfer, solids circulation, and recovery are discussed broadly and future possibilities are indicated.

Abstract No. 82

GRAPHICAL PRESENTATION OF FLUIDS-SOLIDS DYNAMICS

Fluidized Solids Handling in the Metallurgical Industry

F. A. Zenz

In this paper the author develops the construction of generalized fluids-solids flow diagram (phase diagram) in a qualitative manner without reference to any particular fluid-solid system. This development covers not only the region of fluidization in the strict sense, but also the regions of fluidized dilute- and dense-phase solids flow. Several examples are cited showing the phase diagram in relation to processes such as

the roasting and calcination of ore concentrates, fluids-solids nuclear reactors, manufacture of activated carbon, reduction of iron ore, etc.

Abstract No. 83

CHEMICAL REACTIONS IN FLUIDIZED BEDS

F. M. Stephens, Jr., and L. W. Coffer

Increasingly important but less publicized than catalytic cracking are fluidized bed systems in which the solid phase takes part in or is the product of a chemical reaction. Metallurgical processes such as oxidation, sulfate roasting, calcination, vaporization of low boiling constituents in controlled atmospheres, chloridization, and reduction can be carried out efficiently in fluidized bed operations. The advantages and limitations of fluidized bed treatment as compared to more conventional methods for accomplishing chemical reactions will be discussed.

Abstract No. 84

ROASTING SULFIDES IN A FLUIDIZED BED

R. J. Priestley

The fluidized solids technique for roasting is a distinctive departure from conventional roasting practice. Many advantages, including high-strength gas flow, "temperature control," uniformity of product, ease of operation, and flexibility have made this system attractive to many companies.

Abstract No. 85

MODERN TECHNOLOGY AND HIGH-PURITY METALS

Ivor E. Campbell

The importance of high-purity metals in both research and industry is discussed and the wide variation in the degree of purity required in various fields of application is noted. Comparisons are made of the level of purity currently achieved for a number of metals. New techniques of preparation, fabrication, analysis, and evaluation required for high-purity metals are outlined.

Abstract No. 98

FUSION ELECTROLYSIS OF BISMUTH TRICHLORIDE

Paul Gruzensky

Bismuth has been deposited from a fused electrolyte containing 33 wt % bismuth trichloride in a lithium chloride-potassium chloride eutectic mixture as carrier salt at approximately 400°C. The electrolyte was maintained at the desired temperature by the electrolyzing current, requiring 1.2 kwhr of power per pound of bismuth deposited. Cathode current efficiency was nearly 100% and the average yield was 87.7%. The process readily lends itself to continuous operation.

Abstract No. 87

PREPARATION OF PURE NICKEL BY ELECTROLYSIS OF A CHLORIDE SOLUTION

W. A. Wesley

Pure nickel was prepared in the form

of electrodeposits 3–5 mm thick from carefully purified nickel chloride-boric acid solution using iridium-platinum alloy anodes. The over-all reaction is

$$NiCl_2 = Ni_{(metal)} + Cl_{2(gas)}$$

As electrolysis proceeded, purified chloride solution was added automatically to maintain the metal content of the electrolyte. The gas content of the metal is not known, but the total of spectrographically detectable impurities is only 34 ppm. The metal is malleable and some data on mechanical and physical properties are included.

Abstract No. 88

PREPARATION OF HIGH-PURITY RHENIUM

D. M. Rosenbaum, R. J Runck, and I. E. Campbell

Rhenium powder containing a maximum of 0.05% impurities has been prepared by hydrolysis of rhenium pentachloride and subsequent hydrogen reduction of the resultant hydrated rhenium dioxide. Particle size of the rhenium powder is such as to lead to easy densification by methods standard to powder metallurgy. Advantages of this method of preparation over previously employed methods will be given.

Abstract No. 89

VACUUM MELTING AND CASTING OF HIGH-PURITY METALS

N. Darmara

(No abstract received)

Abstract No. 90

FLOATING-ZONE PURIFICATION OF ZIRCONIUM

G. D. Kneip, Jr., and J. O. Betterton, Jr.

Certain impurities in iodide zirconium have been substantially reduced by a fractional crystallization process. The chemical reactivity of zirconium makes necessary the use of a molten zone suspended in the central part of a rod by surface tension. Successive passes of the liquid zone were made to achieve a high degree of purification. Neutron activation analyses and the temperature range over which the α/β transformation occurs for zirconium were used to establish the amount of purification.

Abstract No. 91

CAGE ZONE MELTING

P. H. Brace and G. Comenetz

A short induction coil is set about a long fluted metal rod which stands vertical. A short zone of the rod melts, all except the projecting edges. These remain as the bars of a "cage" that contains the melt. The rod is raised slowly, with the result that the molten zone travels down its length. The condition for zone refining, or for vaporization of volatile impurities or degassing, is thus provided without a crucible. Experiences with titanium, iron, silicon, and molybdenum will be recounted.

Abstract No. 92

QUALITY-CONTROL TECHNIQUES EMPLOYED IN THE PRODUCTION OF HIGH-PURITY ZIRCONIUM

AND HAFNIUM METALS

H. L. Kall

To produce ductile zirconium metal and meet the specifications for this metal as established by the Atomic Energy Commission, it is necessary to control the levels of impurities in zirconium metal rigidly. The quality-control techniques employed by the Carborundum Metals Co. in the manufacture of reactor grade zirconium and hafnium metals will be discussed.

Abstract No. 93

DETERMINATION OF TRACE ELEMENTS IN METALS AND ALLOYS BY RADIOACTIVATION ANALYSIS

G. W. Leddicotte and W. A. Brooksbank, Jr.

Microgram and submicrogram concentrations of many elements appearing as impurities in various metals and alloys can be determined by radioactivation analysis, a specific and sensitive method of analysis in which contamination difficulties as experienced in conventional methods of analysis are negligible.

The method of radioactivation analysis in which neutrons are used as the bombarding particles can be applied to the determination of at least seventy of the elements. Analytical methods are available for the determination of many of these elements in such metals as aluminum, magnesium, titanium, beryllium, zirconium, hafnium, niobium, and their alloys. A general description of the method of radioactivation

analysis, the manner in which samples are irradiated and processed, and some of the results obtained in specific analyses will be presented.

Abstract No. 94

A STUDY OF SEPARATIONS IN THE ANALYSIS OF HIGH-PURITY METALS

O. R. Gates

The application of colorimetric, spectrographic, or x-ray fluorescent techniques to the determination of trace impurities in high-purity metals is not usually possible without preliminary separation of the base metal or isolation of the desired impurity. Separations commonly used preparatory to instrumental analysis are mercury cathode electrolysis, organic solvent extraction, and precipitation with a collector.

A study has been made of these separations in the analysis of high-purity iron for impurities in the parts per million range. Techniques are evaluated in terms of applicability, effectiveness, and limitations, and details for the effective application of each are given.

Abstract No. 95

METALLOGRAPHIC TECHNIQUES

E. E. Thomas

The present emphasis on purity of metals and alloys, now including semiconductor materials, has resulted in heavier demands on metallographic techniques. Newer examination methods such as phase contrast are of great interest and will be briefly outlined.

Cleanliness requirements generally can be satisfied by electrolytic polishing,

as in the case of aluminum. Where mechanical polishing must still be used, great care must be exercised to avoid abrasive contamination. Equally great care must also be exercised not only to avoid material flow but, often, to preserve intact physical configurations of major importance.

Abstract No. 96

SPECIAL TECHNIQUES FOR ANALYZING SEMICONDUCTING MATERIALS

J. M. Whelan

The resistivity, Hall effect, and lifetime of semiconducting materials are extremely sensitive to small concentrations of impurities. From low-temperature Hall-effect measurement, the major impurity in a semiconductor can be identified and its absolute concentration determined. This technique has been used to detect concentrations of impurities in silicon as low as one part in 10^{11}. The measured lifetime of excess current carriers depends on both the surface and volume properties of the semiconductor. This measurement can be used to estimate the maximum concentration of specific impurities in both germanium and silicon.

Abstract No. 97

PREPARATION AND ANALYSIS OF HIGH-PURITY TELLURIUM

S. E. Miller and H. L. Goering

The preparation of high-purity tellurium by sublimation methods is described. The analysis of tellurium is based on Hall effect and resistivity measurements. The efficiency of purifi-

cation is represented by a plot of ionized impurities vs. the number of sublimations.

Abstract No. 98

DUCTILE CHROMIUM

W. H. Smith and A. U. Seybolt

Effects of certain impurities on the room temperature ductility of chromium have been investigated. Results indicate that nitrogen in amounts <0.01% raises the bend transition-temperature of annealed material above room temperature. No effect of oxygen on the ductility in amounts <0.3% was found. Sulfur in amounts as great as 0.1% does not appear to affect adversely the bend ductility of as-cast material, but carbon in amounts greater than 0.02% cannot be tolerated.

Preliminary work on the development of chromium-base alloys containing more than 90% chromium developed many unsolved problems.

Beneficial effects of adding rare earths to tie up harmful impurities in chromium are discussed. Results of mechanical tests on chromium-cerium alloys are presented.

Abstract No. 99

EFFECT OF IMPURITIES ON THE HARDNESS OF TITANIUM

T. D. McKinley

The object of this was to correlate the effect of varying amounts of impurities on the as-cast hardness of titanium buttons prepared under reproducible conditions. These correlations show the relative hardening effect of impurities and allow estimation of

change in hardness with change in impurity level. Data to be presented also allow the estimation of the oxygen content of commercial-grade sponge from hardness measurement and conventional chemical analyses. Estimation of oxygen can be made in this manner with an expected error of 5–10% from values as determined by vacuum-fusion analysis.

Abstract No. 100

EFFECT OF IMPURITIES ON THE TENSILE PROPERTIES OF ALUMINUM

A. P. Young

Very considerable differences have been noted in the flow curves of aluminum single crystals of 99.99% and 99.95% purity. Also, differences in the slip-band structure have been observed. Some of these differences can be accounted for by the dislocation theory of deformation and the effect of impurity atoms on the motion of dislocation.

Abstract No. 101

ADDITION OF CONTROLLED AMOUNTS OF IMPURITIES TO A TITANIUM-MOLYBDENUM ALLOY

S. J. Noesen

A series of 1.25% titanium-molybdenum alloys was prepared by the cold-mold, inert-electrode, arc-melting process. Controlled amounts of the impurities carbon, oxygen, and nitrogen were added singly and in combination to enable the study of their effect on ingot soundness, microstructure, and physical properties.

This paper explains the logic behind the choice of the inert-electrode process to prepare these ingots and the selection and preparation of the raw materials. The melting procedure and data on compositional accuracy obtained are included. An analysis of the cast material is treated at some length.

SPRING MEETING
at the
MARK HOPKINS HOTEL
San Francisco, Calif.
April 29, 30, May 1, 2, and 3, 1956

Sessions probably will be scheduled on

Electric Insulation

Electronics: Instrumentation, Luminescence, Oxide-Cathodes, Phosphor Application, and Semiconductors

Electrothermics and Metallurgy

Industrial Electrolytic

Theoretical Electrochemistry

Abstracts for the Spring Meeting (*not exceeding 75 words in length*) must reach the Secretary's Office, 216 West 102nd Street, New York 25, N. Y. *not later than January 2, 1956* in order to be included in the program.

Indicate on abstract for which division the paper is to be scheduled.

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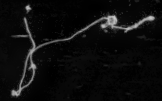

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